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# *Indian Standard*

# METHOD OF TEST FOR DETERMINATION OF THERMAL ENDURANCE OF INSULATING VARNISHES

## PART 2 MEASUREMENT OF LOSS OF MASS

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# *Indian Standard*

# METHOD OF TEST FOR DETERMINATION OF THERMAL ENDURANCE OF INSULATING VARNISHES

## PART 2 MEASUREMENT OF LOSS OF MASS

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# *Indian Standard*

# METHOD OF TEST FOR DETERMINATION OF THERMAL ENDURANCE OF INSULATING VARNISHES

## PART 2 MEASUREMENT OF LOSS OF MASS

## 0. FOREWORD

**0.1** This Indian Standard ( Part 2 ) was adopted by the Indian Standards Institution on 5 February 1985, after the draft finalized by the Solid Electrical Insulating Materials had been approved by the Electrotechnical Division Council.

**0.2** This standard deals with determination of thermal endurance of insulating varnishes by three different methods, covered in a series comprising the following three parts:

Part 1 Electric strength method,
Part 2 Measurement of loss of mass, and
Part 3 Bond strength by helical coil method.

**0.3** This standard ( Part 2 ) covers the method of determining relative thermal endurance of insulating varnishes by measurement of loss of mass.

**0.4** In preparing this standard, assistance has been derived from DIN 46456 — Varnishes and resins for electrical insulation — Impregnating varnishes — requirements, test methods, issued by Deutsches Institut für Normung.

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## 1. SCOPE

**1.1** This standard (Part 2 ) covers the method for determining the relative thermal endurance of insulating varnishes by means of measuring weight of the specimens of varnished glass cloth panels before and after ageing at elevated temperature.

## 2. TERMINOLOGY

**2.1** For the purpose of this standard, the definitions given in IS : 10026 ( Part 1 ) - 1981* shall apply.

## 3. TEST SPECIMEN

**3.1 Glass Cloth Panels** — The glass cloth panels shall be cut from continuous filament, woven glass free from alkali 0·1 mm to 0·18 mm thick with a weight per unit area of 90 $g/m^2$ to 140 $g/m^2$ and with 20 to 26 ends and 16 to 24 picks per centimetre.

The glass cloth shall be heat cleaned to remove binders. The desized cloth should not contain residual size more than 0·2 percent.

NOTE — A suggested heat cleaning procedure consists of heating the cloth 24 hours at 250°C and 24 hours at 400°C.

CAUTION — Heating above 450°C *may damage the cloth.*

Each panel of glass cloth shall be 15 × 30 cm with the 30 cm dimension parallel to the warp threads of the cloth. Each panel shall be mounted and fastened in a suitable specimen-holding frame.

NOTE — Such a frame is made by using a 1 m length of corrosion-resistant wire ( for example, tinned M.S. ) approximately 1·7 mm in diameter, bent to form a rectangle, having inside dimensions of 15 × 30 cm. The ends of the wire may overlap about 5 cm at one corner and be fastened together.

A set of three panels is required for each ageing temperature. A suitable fixture shall be used for holding the specimen frames in the oven in a vertical position with a minimum spacing of 2·5 cm.

**3.2 Varnish Dipping and Drying/Curing** — Test specimens shall be prepared by dipping the mounted glass cloth panels in the varnish at the ambient temperature.

The consistency of the varnish shall be adjusted by trial so that two or more coats will give an increase in thickness of 0·08 ± 0·005 mm over the cloth thickness. The panel shall be immersed in the varnish in the direction of the 30 cm length until bubbling stops. It shall be mechanically withdrawn at a uniform rate of 10 cm/min and allowed to drain for half an hour.

Specimens shall be reversed endwise between subsequent dips to provide a more uniform coat. After each dip, the specimens shall be dried/baked in the same vertical position as the last dip and at the temperature and time specified by the varnish manufacturer.

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*Specification for insulating varnishes containing solvents: Part 1 Definitions and general requirements.

## 4. TEST APPARATUS

**4.1** Weighing balance with an accuracy of 0·001 g.

**4.2 Ageing Ovens** — The air circulating ovens shall be such that the temperature inside the oven does not vary by more than ±2°C from the specified temperature.

## 5. AGEING TEMPERATURE AND TIMES

**5.1** The specimens shall be aged at not less than three, and preferably more, ageing temperatures covering sufficient temperature range to establish the relative thermal endurance. The ageing temperature shall differ by at least 20°C. The lowest ageing temperature shall give a tested thermal life of at least 5 000 hours.

An ageing temperature giving a thermal life of less than 100 hours should not be used.

To reduce the error in extrapolating thermal endurance data and to obtain the temperature index, the lowest ageing temperature should be chosen so that an extrapolation exceeding 20°C should not be necessary.

Choose the exposure temperature so that any essentially linear portion of the life data curve ( log of time to failure v/s the reciprocal of the absolute temperature ) is well established.

For suitable exposure temperature ranges and cycle durations, refer Table 1 of IS : 8504 ( Part 1 ) -1977*.

## 6. TEST PROCEDURE

**6.0** Test specimens are prepared, varnished and dried/baked as described in 3 From these specimen samples measuring 10 × 10 cm are cut so that three samples per exposure temperature are available for the tests.

**6.1** Initially the individual sample panels are weighed to an accuracy of 0·001 gas the first weight $E_1$, $E_2$ and $E_3$ and the mean value $E$ is calculated from them. From the weight per unit area of the glass fabric (**3.1**) (from 90 g/m$^2$ to 140 g/m$^2$ depending upon the thickness of glass cloth ), the approximate weight $G$ of the glass filament support for the 10×10 cm sample is calculated. Finally the value $S$ of the weight of an aged sample is calculated from the following equation:

$$S = (1 - P)\,E + P.G$$

where $P$ is the decimal fraction of total permissible loss in weight, that is, 0·3.

Note — The value $S$ is required as a guide for the conclusion of ageing time in order to understand the final remaining weight of the test specimen after a fixed loss in weight of the specimen.

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*Guide for determination of thermal endurance properties of electrical insulating materials: Part 1 Temperature indices and thermal endurance profiles.

**6.2 Ageing and Specimen Testing** — Specimen shall be suitably tagged or otherwise permanently identified or placed in a suitable holding frames ( *see* Fig. 1 ) and placed in the ageing oven and positioned so that it is at least 10 cm from the walls at any point and the specimens are held parallel to the direction of the air flow.

Specimens shall be removed at the end of the each cycle at respective ageing temperature. After removal, the specimens shall be conditioned for at least 4 hours at 27 ± 2°C at standard atmospheric conditions (*see* IS: 2260-1973*) and then weighed to an accuracy of 0·001 g. The ageing of each sample is continued until its second weight $A$ has fallen below the value $S$.

At the end of ageing, the exact weight $G$ of the glass fabric of each individual sample is determined by burning the specimen over a Bunsen burner or by incineration and weighing the specimen after cooling and conditioning at 27 ± 2°C for 4 hours at standard atmospheric conditions.

The loss in weight $X$ in percentage of the individual sample is,

$$X = \frac{E - A}{E - G} \times 100$$

Note — In the case of varnishes which contain pigments, fillers or resins which do not burn without residue, it is necessary to take into account the constituents of the varnish which result in residue on burning, while determining the loss of mass. For varnishes which contain pigments, fillers or resins, it is necessary to determine the weight of the unvarnished specimen.

## 7. LOSS OF MASS END POINT

**7.1** An end point of 30 percent loss in weight is recommended as the failure criterion.

**7.2** When agreed upon other end points may also be used.

## 8. EVALUATION OF TEST DATA

**8.0** Complete evaluation of detailed test data comprises of the following.

**8.1** Determination of time to reach the end point criterion at each ageing temperature. This is carried out as per **11.2** of IS: 8504 ( Part 1 )-1977†.

**8.2** Determination of thermal endurance graph. This is done as per **11.3** of IS : 8504 ( Part 1 )-1977†.

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*Specification for preconditioning, conditioning and testing of solid electrical insulating materials( *first revision*).

†Guide for determination of thermal endurance properties of electrical insulating materials: Part 1 Temperature indices and thermal endurance profiles.

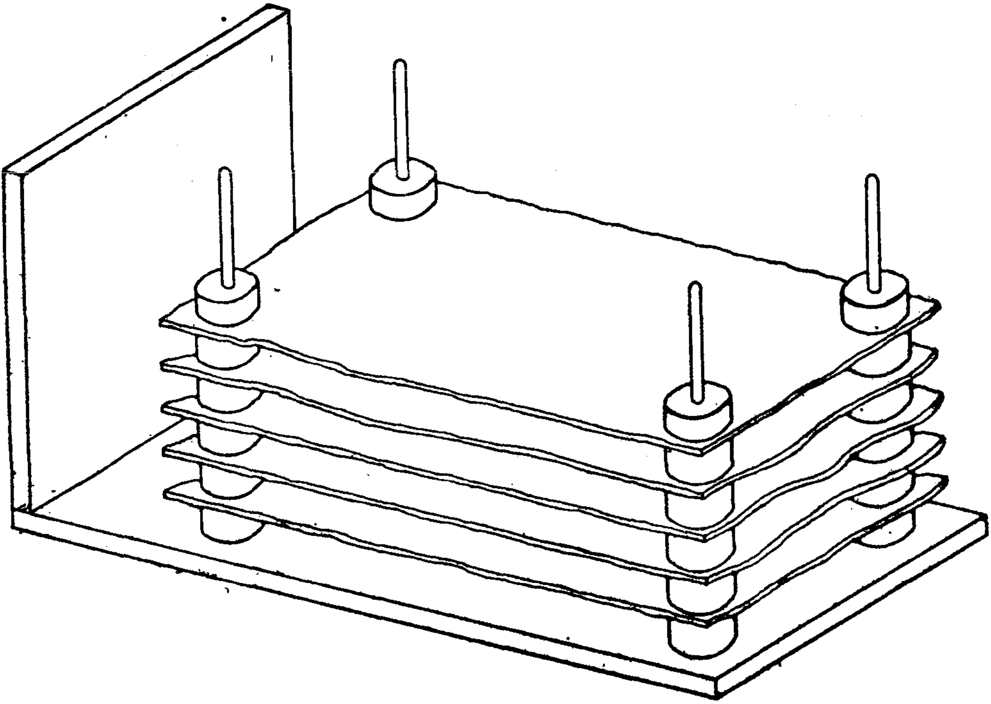

FIG. 1 SUITABLE FIXTURE FOR HOLDING SPECIMENS

**8.3** Determination of temperature index or of the thermal endurance profile as per **11.4** of IS: 8504 (Part 1)-1977*.

## 9. CALCULATIONS

**9.1** Details of statistical methods for determination of thermal endurance profile (TEP) are to be followed as given in Part 3 of IS : 8504†.

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*Guide for determination of thermal endurance properties of electrical insulating materials : Part 1 Temperature indices and thermal endurance profiles.

†Guide for determination of thermal endurance properties of electrical insulating materials : Part 3 ( *under preparation* ).

## 10. REPORT

**10.1** The report should incorporate the following information of the results of this test:

a) The description and identification of the varnish used along with its type, physical properties, the manufacturer, etc;

b) Specific weight per unit area, construction ( ends and picks per centimetre and thickness of glass cloth used );

c) Special treatment of samples, if any. Number of dips necessary to obtain proper build;

d) Drying/curing time and temperature used to prepare specimens;

e) Average thickness of coated glass cloth and its initial average weight;

f) The end point selected;

g) A graph of the relative thermal endurance on a logarithmic time scale as a function of the reciprocal of the absolute temperature;

h) Thermal life at 20°C above the temperature index or the lowest ageing temperature; and

j) The temperature index corresponding to an extrapolated life of 20 000 hours.